COMMERCIAL IN CONFIDENCE

MVEE

MILITARY VEHICLES
AND ENGINEERING ESTABLISHMENT
(CHRISTCHURCH)

<u>THOS STOREY (ENGINEERS) LTD</u>

SHEAR STRENGTH OF ACROW BRIDGE PANELS

Report No.: A 333

Date: August 1977

COMMERCIAL IN CONFIDENCE

NOTE: This report will be regarded as strictly confidential by both Parties to the Contract.

MILITARY VEHICLES AND ENGINEERING ESTABLISHMENT (CHRISTCHURCH)

FIRM	THOS STOREY (ENGINEERS) LTD	XAD/CW/ 6603

SHEAR STRENGTH OF ACROW BRIDGE PANELS

Advisory Report No. A 333

Summary

The ultimate shear strengths of two Acrow panels were determined by building them into a 50 ft single storey, single truss bridge. The shear forces at failure were 51.2 tons and 58.1 tons respectively.

ENGINEER EQUIPMENT (BRIDGING) BRANCH

TEST OFFICER: J V L BARKER CEng MIMechE

Approved: D P T McCabe CEng MIMechE

Authorised

B T B Baiden BSc CEng MICE
for Director

Barrack Road
CHRISTCHURCH
BH23 2BB

August 1977

MILITARY VEHICLES AND ENGINEERING ESTABLISHMENT (CHRISTCHURCH)

FIRM	THOS STOREY (ENGINEERS) LTD	XAD/CW/ 6603

SHEAR STRENGTH OF ACROW BRIDGE PANELS

1. Introduction

MVEE(C) were contracted by Thos Storey (Engineers) Ltd to determine the shear strength at failure of an Acrow Bridge panel.

2. Date and Location of Test

2.1 The tests were carried out on 9 August 1977 under the Bridge Test Rig at MVEE Christchurch.

2.2 A brochure describing the Rig is appended to this report.

3. Description of Equipment Tested

The traditional 'V' or 'U' section of the Male Jaw in Bailey type panels has been known to have some disadvantages in weld type and heat flow characteristics. It has accordingly been replaced with a forged Male Jaw incorporating upper and lower surfaces at right angles to the web of the chord channels and sloping to the centre of the channels, giving improved metallurgical characteristics. The tests are to confirm theoretical parameters and current manufacturing processes.

4. Method of Test

4.1 A 5 bay single storey, single truss Acrow bridge was built under the test rig. The panel to be tested was used as the end panel of one of the girders.

4.2 A load distributing system of beams was erected on the second, third and fourth transoms from the end of the bridge. The beams were arranged so as to load each transom equally. The beams were symmetrically arranged about a point on each transom which divided the distance between the centre lines of each truss in the ratio 106:49.

4.3 During the first test the second panel of the more heavily loaded girder failed in bending - the top chord buckled and the raker bolts sheared. The hamper was then moved towards the end of the bridge so that it loaded the first, second and third transoms.

4.4 Figs 1 and 2 show the arrangements for both loading positions.

5. Method of Test

Force was applied gradually to the Bridge Test Rig until a failure occurred. The maximum force at failure was recorded.

6. Results

6.1 With the load applied to the second, third and fourth transoms the bridge failed in bending when the raker bolts at the fourth transom sheared and the top chord of the second panel buckled. The force at failure was 850 kN.

6.2 Fig 5 shows the failure.

6.3 With force applied to the first, second and third transoms the end panel of the most heavily loaded truss failed when the upper diagonal nearest the end post collapsed.

6.4 Panel 1 failed at an applied force of 857 kN.

6.5 Panel 2 failed at an applied force of 977 kN.

6.6 The shear load in the panel at failure was calculated as:

$$S = \frac{W}{9.968}\left(\frac{516}{611} \times \frac{106}{155}\right) + \frac{6.0}{4} \quad \text{where } W = \text{applied force in kN.}$$

6.7 The shear value for panel 1 was 51.2 tons.

The shear value for panel 2 was 58.1 tons.

6.8 The bending moment at failure during the first test was calculated as approximately 498 tons ft.

6.9 Figs 6, 7 and 8 show the failures.

MILITARY VEHICLES AND ENGINEERING ESTABLISHMENT (CHRISTCHURCH)		
FIRM	THOS STOREY (ENGINEERS) LTD	XAD/CW/ 6603
SHEAR STRENGTH OF ACROW BRIDGE PANELS		

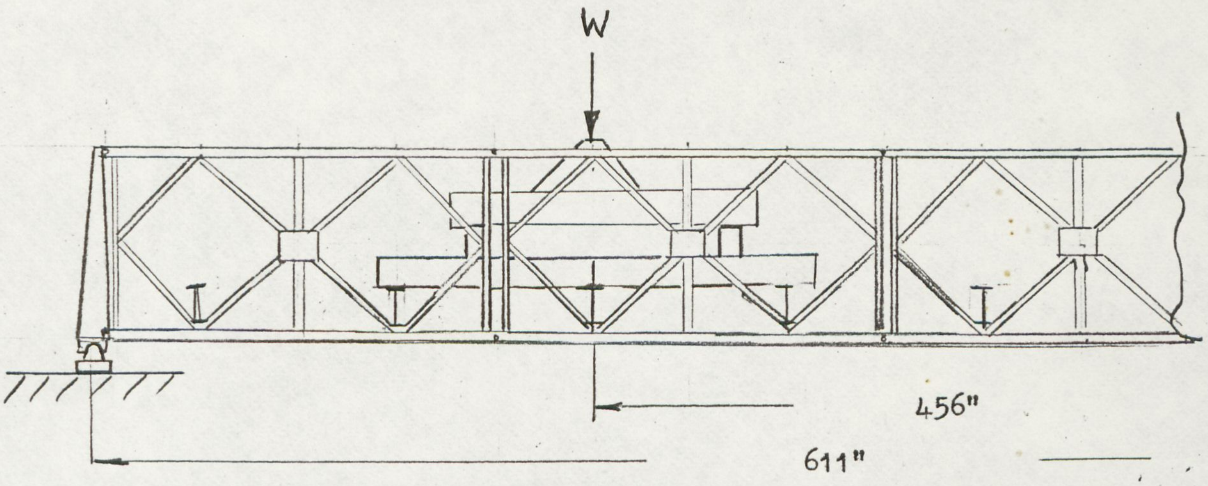


Fig 1 - First loading arrangement

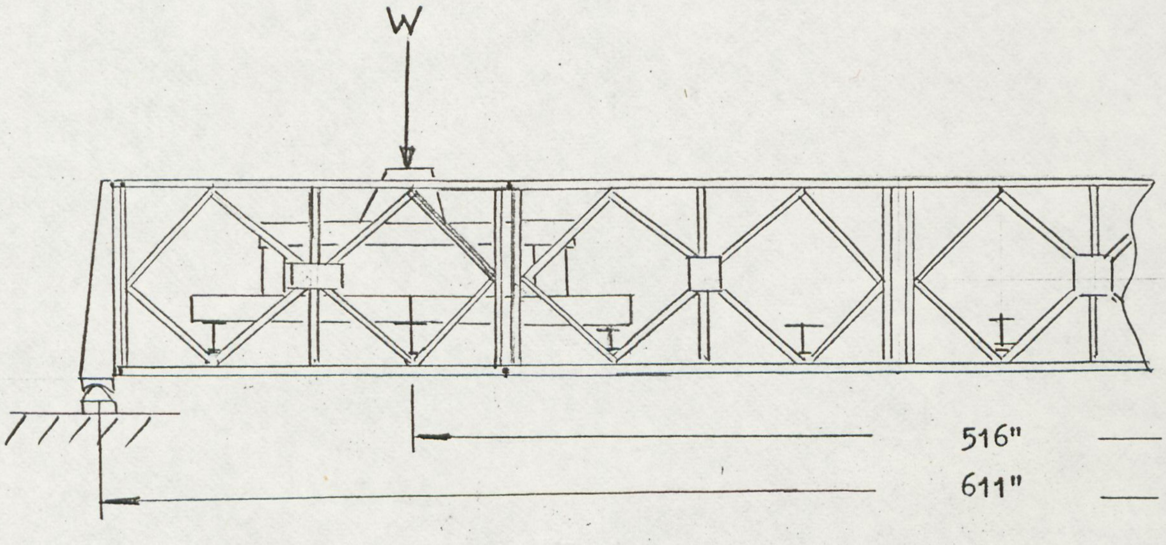


Fig 2 - Second loading arrangement

Pl.299

MILITARY VEHICLES AND ENGINEERING ESTABLISHMENT (CHRISTCHURCH)

FIRM	THOS STOREY (ENGINEERS) LTD	XAD/CW/6603

SHEAR STRENGTH OF ACROW BRIDGE PANELS

Fig 3 - End view of first hamper

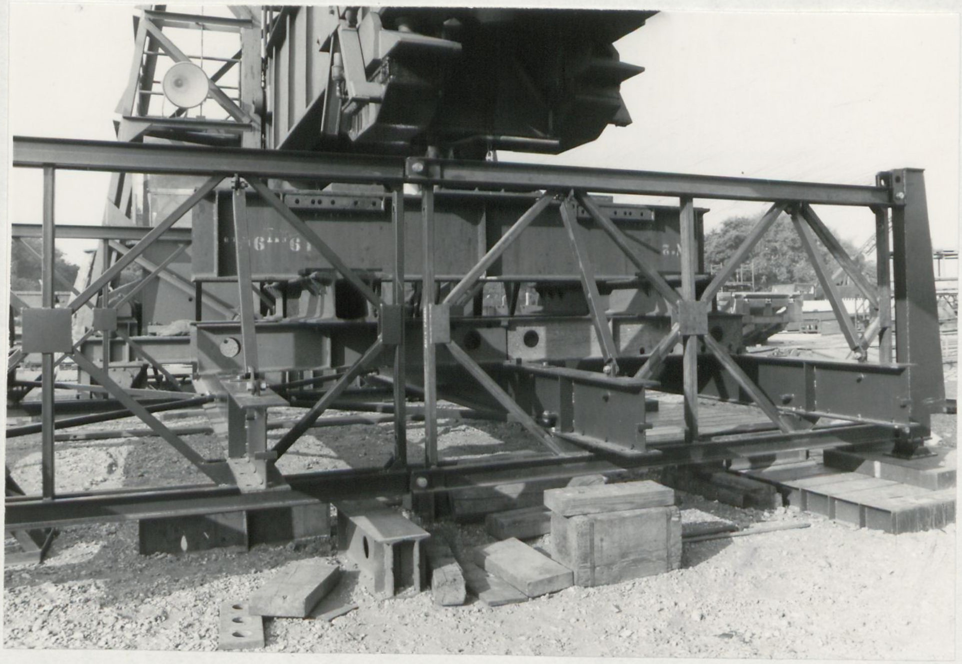


Fig 4 - Side view of second hamper

MILITARY VEHICLES AND ENGINEERING ESTABLISHMENT (CHRISTCHURCH)		
FIRM	THOS STOREY (ENGINEERS) LTD	XAD/CW/ 6603
SHEAR STRENGTH OF ACROW BRIDGE PANELS		

Fig 5 - Bending failure - buckling of top chord

MILITARY VEHICLES AND ENGINEERING ESTABLISHMENT (CHRISTCHURCH)

FIRM	THOS STOREY (ENGINEERS) LTD	XAD/CW/ 6603

SHEAR STRENGTH OF ACROW BRIDGE PANELS

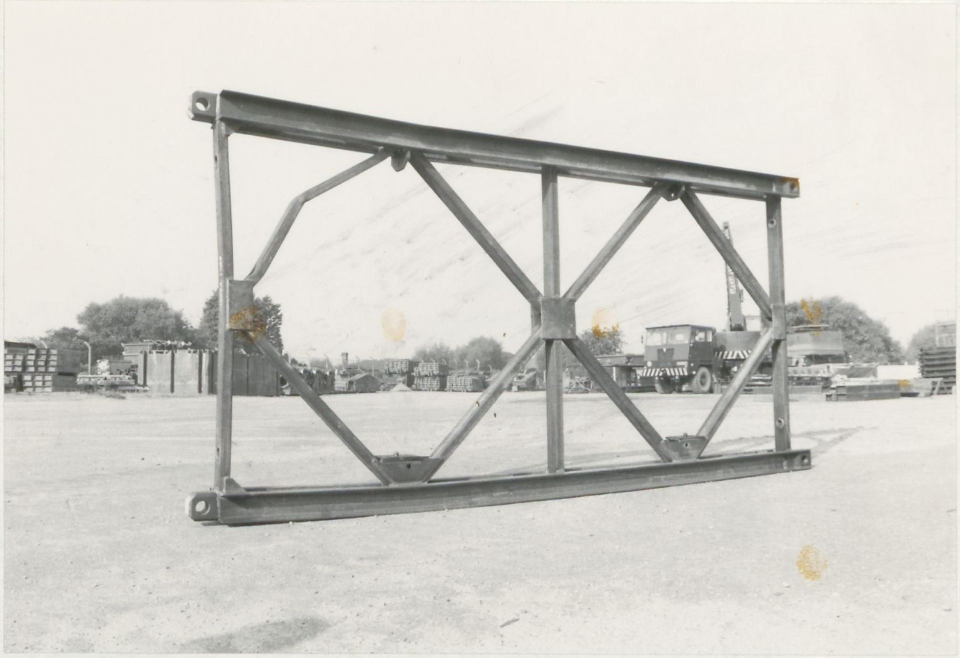


Fig 6 - Shear failure at 51.2 tons of first panel

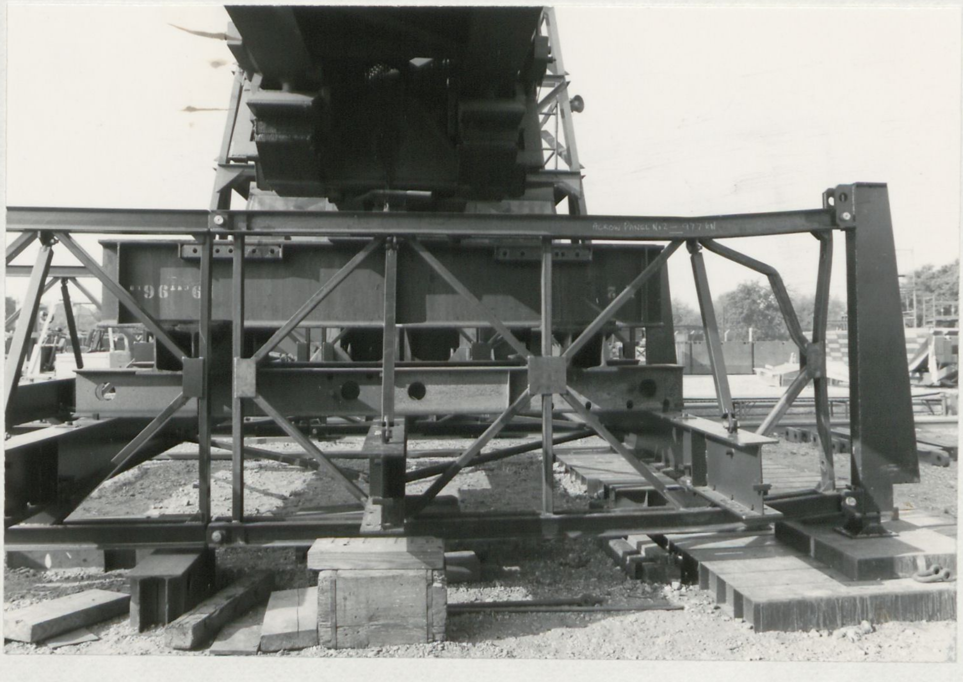


Fig 7 - Shear failure at 58.1 tons of second panel

MILITARY VEHICLES AND ENGINEERING ESTABLISHMENT (CHRISTCHURCH)

FIRM	THOS STOREY (ENGINEERS) LTD	XAD/CW/6603

SHEAR STRENGTH OF ACROW BRIDGE PANELS

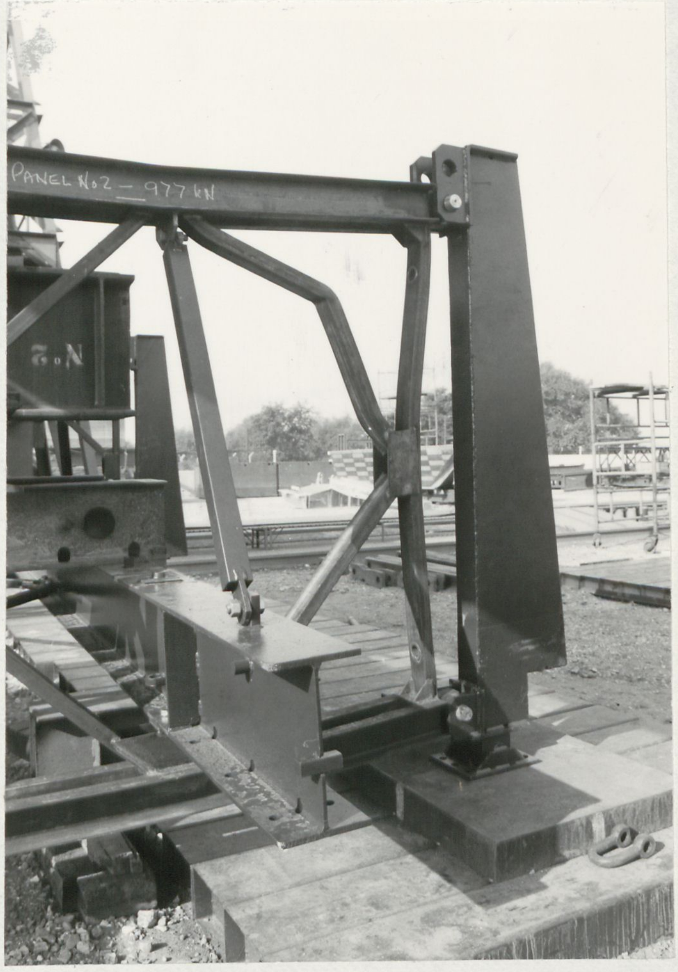


Fig 8 - Shear failure at 58.1 tons of second panel

Pl.299

MVEE

(CHRISTCHURCH)

MILITARY VEHICLES
&
ENGINEERING ESTABLISHMENT

CHRISTCHURCH

BRIDGE TESTING RIG

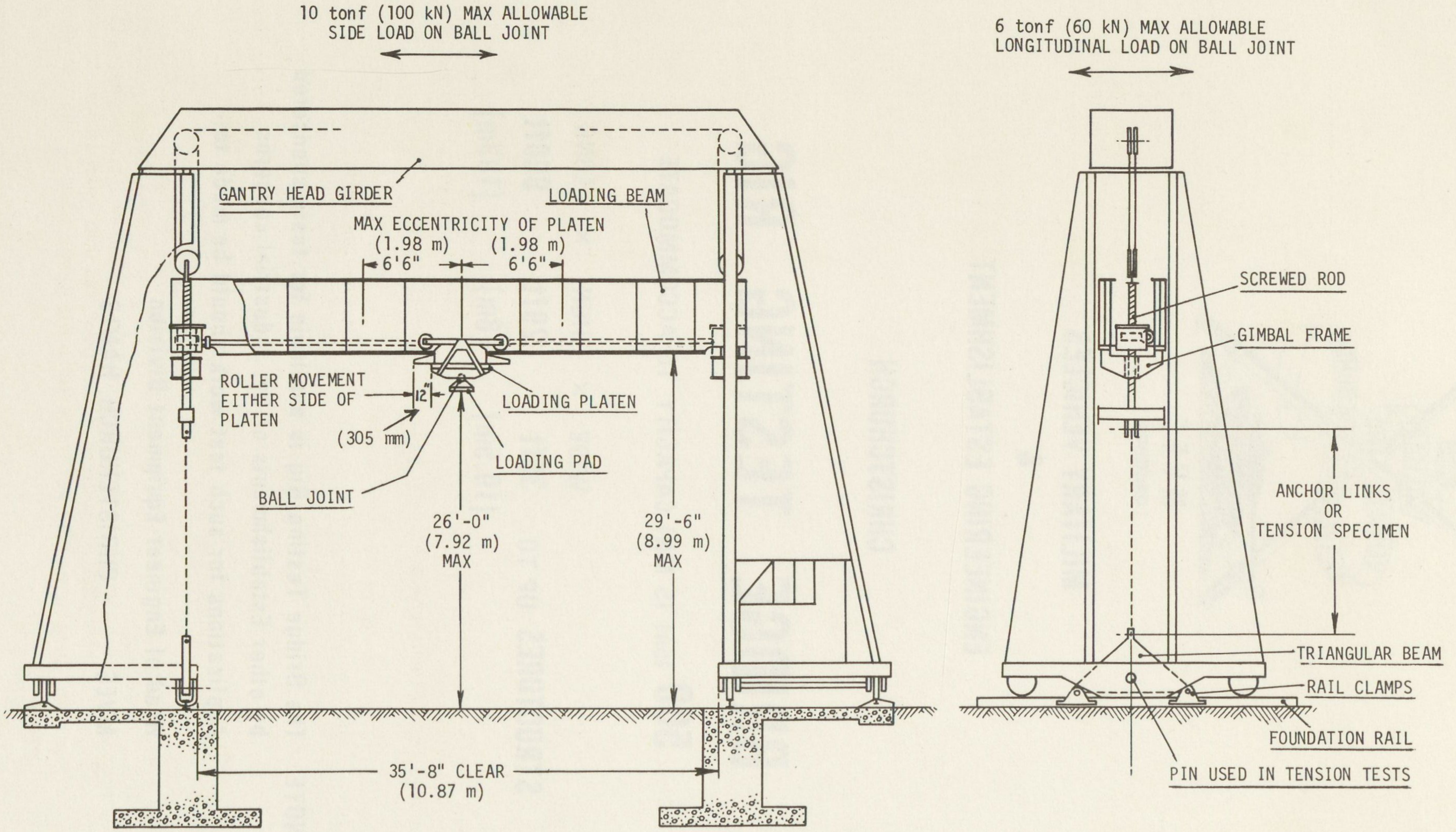
500 tonf (5 MN) CAPACITY TO ACCOMMODATE

	WIDE ×	HIGH ×	LONG
STRUCTURES UP TO	35ft (10.5m)	29ft (8m)	600ft (183m)

NOTE The Bridge Testing Rig is available for tests sponsored by other Establishments or by Industrial concerns Applications for such test work should be made to:-

Head of Engineer Equipment Division

MVEE CHRISTCHURCH, HANTS



MVEE (CHRISTCHURCH) BRIDGE TESTING RIG

500 tonf (5 MN) CAPACITY BRIDGE TESTING RIG

MAIN CHARACTERISTICS

The Rig consists of two, independent, rail-mounted gantries which can be spaced at 19 to 150 ft (5.79 to 45.72 m).

Each gantry carries a loading beam able to apply a downward load of up to 250 tonf (2.5 MN) through the ball joint of a loading platen. This load is distributed to any structure under test through a loading pad surmounting any required arrangement of spreader beams. Structures or structural elements up to 35 ft (10.5 m) wide x 26 ft (8 m) high x 600 ft (183 m) long can be accommodated beneath the loading beams.

Each gantry can also be used to apply tensile loads up to 150 tonf (1.5 MN) to vertically mounted specimens not greater than 15 ft 5 in. (4.70 m) long x 4 ft 9 in. (1.45 m) wide.

APPLICATION OF LOAD

The loading beams can move downwards 40 in. (1.02 m) whilst applying load and so follow up a deflecting structure whilst its rate of descent can be varied during loading from 0 to 1¼ in. (0 to 31.75 mm) per minute to suit the stiffness of the structure under test.

Structures can be loaded eccentrically by setting the loading platen up to 6 ft 6 in. (1.98 m) off centre. Under these conditions, the loading pad tends to move over as the structure twists. To allow this to happen with a minimum of restraint, the lower part of the loading platen, carrying the ball joint, can move a further 12 in. (305 mm)under load relative to the upper part on rollers which separate the two portions. Similarly, the loading pad can move half an inch (12.7 mm) along the axis of the Rig.

MEASUREMENT OF LOAD

All the load applied by the ball joint of the loading platen passes through a load cell placed immediately above it. The load cell is a circular steel column around the middle of which a number of electric resistance strain gauges are mounted. Compressive loads on the cell change the electrical resistance of the strain gauges by amounts proportional to the applied load.

The applied load is normally shown directly in tonf on the dial of a self balancing load indicator to an accuracy of $\pm$ 1 tonf (10 kN).

Should greater accuracy be required, a manually balanced double direct current measuring bridge, designed by MVEE (Christchurch), can be used to measure any applied load to $\pm$ ¼%.

NOTE ON THE OPERATION OF THE RIG

The loading beam is hoisted to any convenient height on SWR tackles passing from a motor in the gantry head girder to the top of two screwed rods, each rod passing through a motor driven nut mounted in a gimbal frame at each end of the loading beam.

As cross heads prevent rotation of the screwed rods, the loading beam is driven up or down the screwed heads when a motor in the loading beam turns the nuts.

Anchoring the lower end of each screwed rod to the inner foundation rail by means of anchor links, a triangular beam and two rail clamps enables the loading beam to be driven down to load a structure in compression since the upward reaction on the loading beam is resisted by the dead weight of the massive concrete foundations to which the foundation rails, and hence the anchor links, are attached.

By securing the loading beam to the head girder and letting the screwed rods move vertically relative to the loading beam when the nuts are turned, tensile tests can be carried out on specimens placed between the end of a screwed rod and the triangular beam beneath it. In such tests, the rail clamps are disengaged and the load in the triangular beam is taken by a pin in the gantry base frame so that the inner legs of the gantry tower take the compressive reaction.

Each gantry is operated from a control cabin built into one of its towers and numerous limit switches and safety devices prevent overloading or misuse.

March 1971